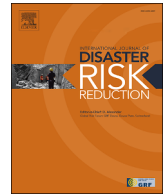


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Perception of climate change and geo-hydrological risk among high-school students: A local-scale study in Italy

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ABSTRACT

Natural hazards can produce relevant impacts on people, particularly on their life, health, properties, that are expected to increase for climate change. Sustainable approaches aiming at mitigating, adapting and reducing the vulnerability of people exposed to these hazards have to be based on the analysis of the risk perception. Many aspects (e.g. social, cultural, psychological) even autocorrelated, can affect the perception assessment. Furthermore, identifying factors that influence or determine risk perception can help to implement more effective communication strategies. In this paper, the Italian young people's awareness, perception and preparation about natural risks, mainly landslide and flood risk, as well as climate change are investigated. A survey was carried out by means of voluntary questionnaires on a group of Italian high school students, aged between 13 and 20, in central (Umbria region) and southern (Calabria region) Italy. The results reveal that the students surveyed are aware of the climate change issue and of the its effects on nature and environment. The output of the two surveys confirms the relevant role of mass media in terms of perception, knowledge and information about climate change and related impacts on young people. Moreover, a low level of trust in local administrations and a negative opinion on the policy about geo-hydrological risk have also emerged.

1. Introduction

Natural hazards, such as floods and landslides, significantly affect people's life, health, and properties. Climate change (CC) and population expansion in high-risk areas are expected to increase these impacts [1,2]. In fact, 91% of all disasters in the period 1998–2017 were climate-related, including those caused by geo-hydrological hazards. In particular, 48% of such disasters were due to floods (42%) and landslides (5%), which affected 2 billion and 5 million people, respectively, and claimed around 145 thousand human lives [3]. According to the Emergency Event Database, almost 4 billion people were affected by more than 6000 climate-related disasters, and more than 500,000 lost their lives in the 20-year period 2000–2019. These numbers have double if compared to similar estimates in the period 1980–1999 [4]. In the areas where observational data are sufficient for trend analysis, it has been shown that the frequency and intensity of heavy precipitation have increased since the mid-20th century; moreover, heavy precipitation and its effects are expected to intensify and become more frequent all over the world [1].

A sustainable approach for risk reduction, implemented through actions with zero environment impact and without structural measures, is based on the analysis of risk perception [5]. The latter is defined as the people's subjective judgment in characterizing

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and assessing hazards [6] and it is linked to the specific risk for which it is estimated [7,8]. For this reason, perception assessment can be influenced by different factors (e.g. social, psychological, cultural), even autocorrelated [9]. Understanding citizens' risk perception is important to disseminate the necessary information and to increase trust toward public authorities [10,11]. Furthermore, identifying the factors determining how individuals and communities perceive risks can help to implement more effective communication strategies [12].

For the European territory, several studies addressed different aspects of knowledge, perception and preparedness to natural hazards and impacts of CC by adults, at different spatial scales and using different methodologies (e.g., Refs. [12–32]). Remarkably, [31] pointed out that despite the global concern about Covid-19 pandemic, CC is ranked as the most likely threat by both Italian and Swedish citizens.

Recently, a number of studies have evaluated the natural hazard risk perception of young people/children worldwide. [33] explored the role of knowledge in the individual flood-risk perception among students in the Netherlands. [34] studied college students' earthquake risk perceptions in Oklahoma, USA. [35] surveyed the risk perception (with a particular focus on knowledge and fear) regarding different natural hazards among university students of Turkey, Macedonia and Serbia. [36] carried out a local and national scale assessment of the Portuguese students' risk perception. [37] evaluated the perception of geo-hydrological and seismic risks in different school levels in Tuscany region, Italy. [38] determined the disaster risk perception related to man-made and natural hazards of university students in Turkey. [39,40], and [41] investigated children's flood risk perception.

At the same time, many international papers provided a broad portrayal of young people's knowledge, engagement, concern, and perception on CC issues ([42] and references therein). The results, although based on different participatory methodologies and sampling, show that a strong majority of high school/under graduated students believe that CC is taking place and is being caused by human activity, despite their being unfamiliar with the science behind CC [43–47]. In their recent review, [42] analyzed researches about youth perception of CC carried out between 1993 and 2018. The analysis highlights that the differences in belief and concern about CC and perception of its causes/consequences are related to age and place of children and adolescents. According to several studies, young people perceive CC to primarily affect places far from where they live and people different from them [48–50].

The available literature suggests limited progress in climate education in many educational systems of developed societies [47,51,52]. [44] found that student's perceptions of the CC associated risks increased after they learned CC science during a course. Furthermore, the low students' perception of individual responsibility, identified in various researches [46,53,54], highlights the need to devise more effective strategies to facilitate better individual behaviours related to CC and its consequences. In this, education can be a primary factor in raising environmental awareness among young people, by communicating CC and its impacts [55,56]. The need and importance to promote CC education and programmes in order to raise awareness of educational institutions are also highlighted by [57].

Different studies indicate that Italy is already characterized by a high frequency and intensity of flood and landslide phenomena. Moreover, due to the expected changes in rainfall patterns and features, the situation might get worse in the future [58–60]. In this framework, knowing Italian young people's sensitivity and preparation towards these issues is becoming increasingly important. The aim of this study is to investigate the Italian young people's awareness, perception and preparation concerning natural risks, including landslide and flood risk, and CC. In particular, this survey wants to analyze: (i) the students' level of knowledge about geo-hydrological phenomena; (ii) the sources from which the students obtain information on risk; (iii) the most efficient source of communication to get information before or during the occurrence of a geo-hydrological events; (iv) the students' level of feeling of safety; (v) awareness, knowledge and information about CC; (vi) psychological attitudes towards CC and their impacts and effects. For this purpose, an exploratory study based on questionnaires to high school students, aged 13 to 20, in central (Umbria region) and southern (Calabria region) Italy was conducted.

2. International and national policy framework

One of the objectives of the European Green Deal and of the 2030 Agenda for Sustainable Development is to set new policies for countering the environmental impacts of CC, with the involvement of governments, civil society and private sector. The urgency to increase the efforts is likely due to numerous events, mainly organized by young people, which have sensitized public opinion and politicians on the theme of CC. In particular, the role of the new generations is fundamental in this context; it is now common belief that only by involving young people it will be possible to create a “future for our planet” [48]. The Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030, in accordance with the 2030 Agenda agreements, encourages the participation of young people in the context of disaster risk reduction, recognizing them as “agents of change” [61]. In line with the SFDRR and the major global frameworks, the Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector (GADRRRES) recently revised its Comprehensive School Safety Framework (CSSF), which was developed in 2012 (<https://gadrres.net/1>, last accessed 06/01/2023). In particular, the CSSF 2022–2030 encourages countries to renew their commitments to disaster risk reduction and resilience in the education sector (Pillar 3: Risk reduction and resilience education; (<https://gadrres.net/comprehensive-school-safety-framework>, last accessed 06/03/2023). Although bottom-up strategies involving citizen participation in disaster risk reduction are spreading worldwide [62–64], the active participation of children and young people in Europe is still poor. From a study carried out in Greece, Italy, Portugal, Spain and the UK within the project CUIDAR, funded by the EU Horizon 2020, it was found that children and young people are rarely included in disaster management as they are considered primarily a vulnerable group [65].

From the above international framework it is evident that institutional, political and legal frameworks are essential on the prevention and the reduction of disaster risks, as well as in reducing the impact of adverse events. For an effective disaster risk reduction, involving and empowering citizens, in particular young people, is an important aspect. In Italy, disasters' management is entrusted to

National Civil Protection Service (Italian D. Lgs. 224/02.01.2018). Apart from the activities of prevention, mitigation, and emergency response, it is the Civil Protection's task “the dissemination of knowledge and culture of civil protection, also with the involvement of educational institutions, in order to promote the resilience of communities and the adoption of conscious behaviour and measures of self-protection by citizens” (<https://www.protezionecivile.gov.it/it/normativa/decreto-legislativo-n1-del-2-gennaio-2018-codice-della-protezione-civile>, last accessed 20/01/2023). According on these needs, in addition to the national communication campaign “I don't take risks” (<https://eventi.protezionecivile.gov.it/en/i-dont-take-risks>, last accessed 20/01/2023), the Italian Civil Protection and the Ministry of Education have recently designed a project for spreading good civil protection practices among the younger generations (<https://giovani.protezionecivile.gov.it/en/memorandum-understanding-ministry-education>, last accessed 20/01/2023). Moreover, starting from the school year 2020/2021, Italian students of all ages have been sensitized, among other issues, to the risks of their Country, thanks to the introduction of Civil Education as a compulsory subject in the school programmes (Italian Law 92/2019).

Regarding climate-related risk, the Italian Ministry of Environment and Energy Security and the Italian Institute for Environmental Protection and Research promoted and realized a National Platform on CC adaptation (<http://climadat.isprambiente.it>; last accessed 06/03/2023), aiming at informing, raising public awareness and releasing data from different sources to support the institutions involved in the decision-making process on the issue of CC adaptation.

3. Materials and methods

3.1. Study areas

The study areas were selected on the basis of two criteria: a) Umbria and Calabria are among the Italian regions most prone to geo-hydrological phenomena and b) the authors working in the Institute's offices located in the two regions have greater knowledge and awareness of the natural hazards in these territories (Fig. 1).

According to the last report of the Italian Institute for Environmental Protection and Research [66], in Calabria the flood hazard areas cover 2622.6 km² (17.2% of the whole territory) and the landslide hazard areas cover 54.3 km² (2.3%), while in Umbria flood and landslide hazard areas cover 368.6 km² (4.4%) and 494.5 km² (5.8%), respectively. According to the same report, 147,486 and 174,630 people live in landslide hazard areas in Calabria (7.5% of all residents) and Umbria (19.7%), respectively. On the other hand, 250,035 and 63,947 residents live in flood hazard areas in Calabria (12.8%) and Umbria (7.2%). In addition, regarding seismic risk, in the map of the seismic classification of the Italian territory, the two study areas respectively fall into the Zone 1, that is the most dangerous area where major earthquakes may occur, and the Zone 2, which is the area that can be affected by quite strong earthquakes (Dipartimento della Protezione Civile Nazionale, Classificazione sismica al 2022. <https://rischi.protezionecivile.gov.it/it/sismico/attivita/classificazione-sismica>; last accessed Feb. 2023).

3.2. Research method and data collection

The methodological design of this exploratory research is quantitative. It applies a closed-ended questionnaire on young people's perception of natural risks, particularly landslide and flood risks (geo-hydrological risks) and CC. The social science literature offers a variety of qualitative/quantitative tools for understanding processes, experiences, and the meanings people assign to things. In particular, questionnaires can help gathering respondents' attitudes, experiences, and opinions on a specific subject, through a list of specific questions or items. The collected data analyzed in this paper are from two surveys carried out using structured questionnaires involving high school students. Of the three different methods (email/online, phone, face-to-face), we chose to use the online procedure by means of the Google Form platform because the cost involved in the online survey research is usually minimal. The two surveys were carried out in two different periods: in 2016 (Umbria) and in 2021 (Calabria). However, the questionnaire have been developed

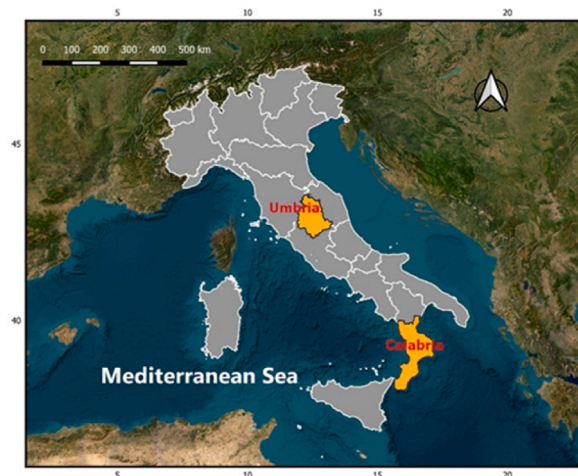


Fig. 1. Location of the study areas.

and performed in the framework of two different research projects; therefore, they only have three questions in common. Moreover, only the questionnaire administered to high school students in Calabria was designed to also investigate the young people's perception of CC by adding specific questions on this issue.

For this research, a convenience sampling technique was applied, limiting participation to young people aged between 13 and 20. In order to have an adequate sample, high secondary schools of Calabria were invited to let pupils in the aforementioned age range participate on a voluntary basis. In order to conduct interviews, parents or guardians of the students were also asked for their consent by means of the school heads. Students were made aware of the questionnaire's scientific goals and were reassured that their identities would be kept anonymous.

The sample cannot be regarded as representative of the larger Italian population due to the data gathering methodology used. We restricted the analysis of this study to the group of respondents who resided in the two regions. Nonetheless, the sample size is at least adequate to make comparisons with other studies on the same topics and to make judgments about the perception of geo-hydrological risk and CC in the local area.

The questionnaires include 18 and 12 questions of different type for the Umbria and Calabria case studies, respectively (Appendix A). Different aspects were evaluated (e.g., knowledge of the phenomena, risk perception in the area of residence, perception of personal vulnerability, trust in different information sources, and perceived responsibility) using multiple choices or dichotomous questions, and Likert scale [67]. The survey was designed considering previous works to allow comparison between findings. Three questions were common to the two surveys, in order to test the students' level of perception of geo-hydrological phenomena. All questions were mandatory to complete the surveys; however, the "I don't know" answer was often available. In the following sub-sections, the two surveys are described in detail.

3.2.1. The survey in Umbria

In April 2016, as a part of the initiatives dedicated to the 50th anniversary of the 1966 flood in Florence [68], an informative campaign specifically dedicated to high school students was organized in Umbria in collaboration with the regional educational department. The aim of the project was to raise the awareness on natural hazards, and particularly on geo-hydrological phenomena. In this framework, a survey specifically designed for high school students was conducted. The survey included 50 questions aimed at investigating the young people's perception of landslide and flood risk, also in relation with possible climate change-related causes. The questionnaire included, on purpose, some questions already used in national surveys, previously carried out to investigate the perception of geo-hydrological risk in Italy [16]. This is a common procedure, useful to investigate trends and changes in the answers. The questionnaire was sent to several high schools in the regions, authorized by the regional school authority. Finally, 58 fully answered records were selected. The age range is 14–20. The number of respondents is in line with a similar survey, limited to flood risk, conducted in the same period on students of Tuscany region [32].

For the scope of this study, only 18 out of all the 50 questions were taken into account. Table A1 shows the list of the queries analyzed in this paper. In particular, a question on the information about natural and human induced causes that control landslide/flood hazards and risks was included. Moreover, other questions dedicated to communication channels preferred by students to be informed on such risks, also in emergency phase, were included. More in detail, these questions concerned: (i) the sources from which the students obtain information on risk; (ii) the factors that they consider to be the main cause for flood and landslide occurrences; (iii) the most efficient source of communication to get information before or during the occurrence of a geo-hydrological events. These latter questions are in common with the survey conducted in Calabria in 2021.

3.2.2. The survey in Calabria

Taking into account that the expected CC might increase the frequency and the intensity of damaging events, the survey carried out in Calabria was mainly focused to investigate the young people's perception, knowledge and information concerning CC and how it can affect flood and landslide risk. The survey was carried out within the "SuperScienceMe2021" Project, funded for the EU initiative "2021 European Researchers' Night" (<https://www.superscienceme.it>, last accessed 15 Nov. 2022), with the goal of promoting research among young people and schools. Among the Calabrian high schools (in Italian *Istituti di Istruzione Superiore*) invited to participate in the survey, two high schools positively answered. They are located in Rossano and Cariati. The students involved were 362 (57% of Rossano and 43% of Cariati); female students represented 58% of the sample and the age range is 13–19. The data were collected in September/October 2021 through a structured questionnaire with 12 closed-ended questions aiming at characterizing the students' perception, beliefs, motivation, attitudes, and knowledge about CC and geo-hydrological risks. (Table A2). Also this questionnaire included, on purpose, some questions already used in a previous survey [12]. In particular, one section of the questionnaire, from [12] and modified for the aim of the "SuperScienceMe2021" Project, encompasses five questions probing the students' perception of geo-hydrological risk. This section explores: (i) level of knowledge (awareness) about geo-hydrological phenomena; (ii) the most efficient source of communication before or during the occurrence of a geo-hydrological events; (iii) the students' feeling of safety. Another section of the questionnaire aims at measuring the students' perception of CC. This section includes 7 questions about: (i) awareness, knowledge and information about CC; (ii) psychological attitudes towards CC and their impacts and effects. The data were collected online, using the computers available in the school's computer lab, with the presence of the teacher: the time available was 30 min.

3.3. Data analysis

To quantify and to describe the questionnaires' results, descriptive statistical analysis was carried out. Subsequently, to analyze in details some specific questions considered descriptive for explaining the feeling and knowledge of the students to CC and geo-

hydrological risk, some of the answers included in the two questionnaires were compared pairwise. To perform quantitative comparisons, the qualitative answers to some questions were converted into numerical values from 1 to 4, assigning the value 4 to “considerably”, 3 to “somewhat”, 2 to “a little”, and 1 to “not exposed”. Finally, 0/1 values were assigned to the dichotomous Yes/No responses.

4. Results

4.1. Students' perception of landslide and flood risk in Umbria

The first question (QU1 in Table A1) aimed at evaluating the perception of the risks linked to landslides, floods, and earthquakes (natural hazards), road accidents and environmental pollution (technological hazards), and to robberies and terror attacks (social hazards).

Fig. 2A shows the results of all answers, with a focus on the sum of “considerably” and “somewhat” answers for the survey, revealing that the young interviewees felt more exposed to earthquakes, which totalized the maximum value of “considerably” and “somewhat” answers (62%). On the contrary, the landslide and flood risk perception is very low (16% and 14%, respectively). As for the technological risks, in Umbria the most perceived is the car accidents (52% of “considerably” and “somewhat” answers); conversely, the environmental pollution scores (44%) reflects the common saying that Umbria is the “green heart of Italy”. Among the social risks, robberies scored the highest sum of “considerably” and “somewhat” answers (48%).

The second question (QU2 in Table A1) was focused on landslide and flood risk, and aimed at determining if the young interviewees had a direct experience or an indirect knowledge on landslides or floods occurred in their municipality. Results indicate that the majority of the Umbrian young interviewees (57%) have not directly experience or have indirect knowledge of landslides or floods occurred in the area where they lived.

The third question (QU3 in Table A1) aimed at determining if landslides and floods were considered dangerous for personal safety. Two possible choices were provided: “Yes, I consider landslides or floods as threats to my personal safety”, or “No, I do not consider landslides or floods as threats to my personal safety”. According to the results, a relatively high percentage of interviewees (59%) considered landslides and floods dangerous for their personal safety.

The fourth question (QU4 in Table A1) was designed to investigate how the young interviewees were able to evaluate the frequency/likelihood of landslides, floods, and earthquakes occurrences in their municipality or in the proximity of their house. Results are summarized in Fig. 2B, and agree with those of the first question. In fact, the earthquake results the most perceived hazard in Umbria with a very high value (71%) compared with the other hazards. On the other hand, floods and landslides totalized very low percentages: 14% and 7%, respectively.

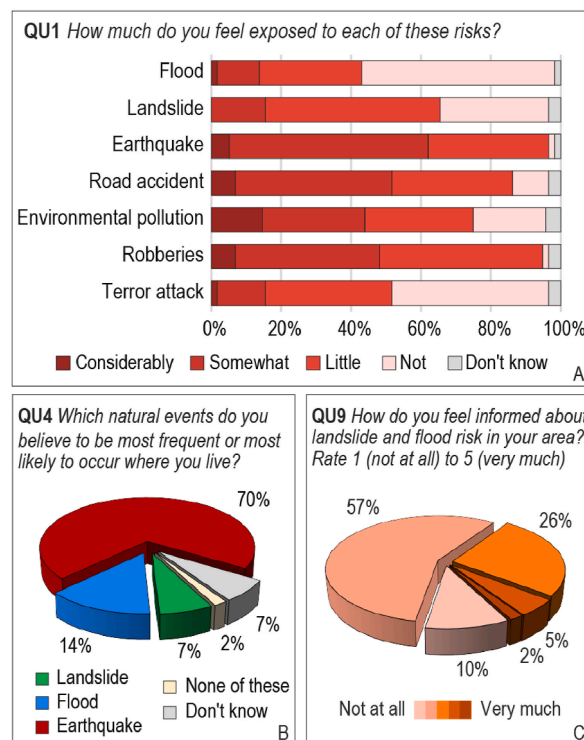


Fig. 2. (A) Answers to QU1; percentage of interviewees feeling “considerably”, “somewhat”, “little”, or “not” exposed to the listed hazards. (B) Answers to QU4; percentage for each single possible answer. (C) Answers to QU9. percentages of answers rated from 1 (not at all) to 5 (very much). See Table A1 for the complete questions and the list of the possible answers.

A further question aimed at investigating the perception of damaging events: it was asked to select among possible tangible damages that can be due to the occurrence of a landslide or a flood (QU5 in Table A1). Overall, 48% of the respondents were afraid to suffer damage by such events. More in detail, half of them identified their house as the most damageable property, followed by cars and agricultural land.

Another question (QU6 in Table A1) was focused on why landslides and floods can represent a hazard for the society. Multiple choices were provided. The highest score (38%) was obtained by “Because they are unpredictable”, followed by “People adopt misconduct” (20%), “Structural mitigation measures are lacking” (20%), and “Houses were built in areas at risk” (15%).

Two questions (QU7 and QU8 in Table A1) were dedicated to investigate if the young people knew the factors that can cause a flood or a landslide. A large variety of causative factors for both phenomena were provided and the analysis of the answers revealed that the most selected choices were clogging of manholes or sewers (44.6% of positive replies) and intense, prolonged rainfall (53.0% of positive answers) for floods and landslides, respectively. Contrarily to what expected, a dike breach or a fluvial overflow were not selected as causative factors for floods. On the other hand, human actions as road cuts or excavations, and other mining activities were not considered relevant for landslide initiation, as well a natural causal factor like snow.

Seven questions (QU9 to QU15 in Table A1) aimed at investigating how much the students felt informed about landslide and flood risks (QU9 in Table A1) and if they knew what to do in case of their occurrence (QU10 in Table A1). Regrettably, as expected, 67% of the respondents said that they are poorly or not at all informed on such risks; while only 7% said that they are very well informed (Fig. 2C). Moreover, only 47% of them said that they know how to react in case of landslide or flood. Furthermore, they were asked if they are aware that their municipality has prepared a civil protection plan (QU11 in Table A1). Only 17% of the respondents knew or were aware of the local civil protection plan, while 83% don't have any information about it. Finally, 47% of the respondents were aware that a regional alert system was operating in Umbria (QU12 in Table A1), while only 10% of them participated in education or informative campaigns (QU13 in Table A1), thus confirming their very low level of information on geo-hydrological risk. Another question aimed at evaluating which information source on landslide and flood risk they trust more, among press, internet, environmental organizations, experts, civil protections, police forces, mayor, friends, and old people living in their area (QU14 in Table A1). Despite the overall scarce level of information observed among the youngsters, they recognized experts and civil protection as the most trustworthy information sources, which 50% of “considerably” and “somewhat” answers, followed by press and police forces. The lower percentages of positive answers (17%) were obtained by friends, old people, and mayor.

To conclude this topic, students were asked who is accountable for making them informed in case of flood or landslides (QU15 in Table A1). Interestingly, 76% of them feel directly involved in the responsibility of getting informed, while the remaining 24% think that this is a task totally or mainly pertaining to the institutions.

4.2. Students' perception of climate change and landslide/flood risk in Calabria

The first four questions were finalized to rank young people's awareness, knowledge and information about CC.

Students' awareness of CC was surveyed through the question “Do you believe that CC is globally in effect?” (QC1 in Table A2). Nearly all respondents (92%) answered “yes”, while 6% answered “I don't know” and 2% “no”.

As for knowledge about CC, the students were asked a multiple-choice question on what phenomena are linked to CC (QC2 in Table A2). Fig. 3A shows the number of single replies per each option. The most frequent answer was “melting of ice and sea level rise” (252 answers) and “increases of temperatures” (230) followed by “ozone hole and greenhouse effect” (140), “increase in the frequency of extreme events such as hurricanes, tropical storms, floods, heat and cold waves” (138), “loss of biodiversity and loss of animal and plant species” (126), “drought and desertification” (65) and “increase of immigrations and social conflicts” (10).

The students were asked for their opinion, on a 5-level scale re-classified into three categories (disagree, agree, strongly agree), on four statements related to the CC issue (QC3 in Table A2). Fig. 3B shows the percentage of interviewees that responded “strongly agree”, “agree”, or “disagree” to each statement. A considerable number of students strongly agree (43%) or agree (32%) with statement that “climate change are linked to the economic policies of the most industrialized Countries” while fewer students are “disagree” (16%) or “don't respond” (9%). The majority of respondents (82%) does not agree with the statement that “climate change is a journalistic mount”, while 63% of the sample think that “climate changes are also tied to daily lifestyles”. 48% of respondents disagree with statement that “climate changes are linked to natural evolution of the Earth” while 22% and 21% of the students agree or strongly agree, respectively.

As for the government action to mitigate CC (QC4 in Table A2), over half (55%) of respondents think that national and international policy measures to face this problem are insufficient, although many think that policy measures are being taken (22%) or don't respond (23%).

The following three questions were finalized to know psychological attitudes towards CC and their impacts/effects of the young people interviewed. Regarding students' perceived concern about CC impacts, the most frequent answers to the multiple-choice question (QC5 in Table A2) were “nature and environment” (293 answers) and “population of all over the world” (202), followed by “myself, my family and the community where I live” (80 answers) and “my nation: Italy” (23).

Regarding the effects of CC (QC6 in Table A2) a considerable number of students (74%) think that these effects are already happening, 13% think that they will be evident in next 50 years (Fig. 3C), and only 2% exclude that they will be seen in the future.

Fear, trust, frustration (psychological attitudes) of students towards CC were investigated through a question in which they were asked to give their opinion on a series of statements (QC7 in Table A2). Most of the students have shown that they agree with the sentence “I am afraid of the possible effects of climate change” (46%) and “I am frustrated because not enough is being done about climate change” (28%), while only 16% of the sample agree with the statement “I am confident that we will succeed to slow down climate change”.

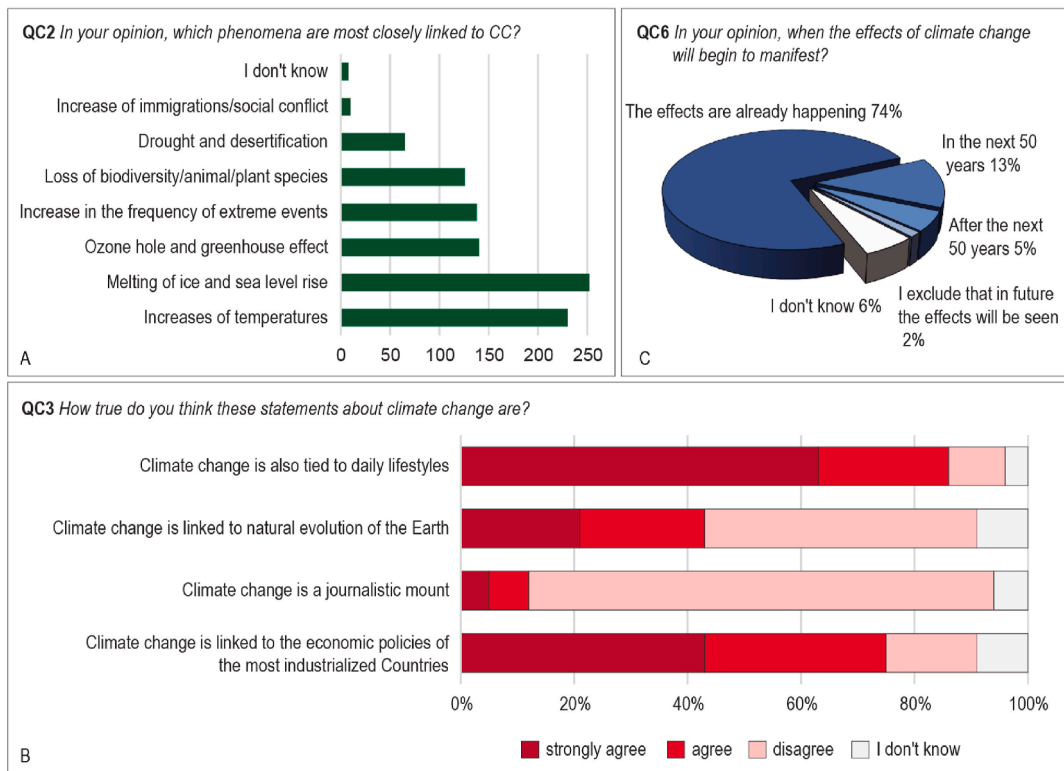


Fig. 3. (A) Answers to QC2. Bar chart showing the number of single replies. (B) Answers to QC3; bar chart showing the percentage of interviewees that responded “strongly agree”, “agree”, or “disagree” to each statement. (C) Answers to QC6; pie chart shows the percentage for each single possible answer. (C). See Table A2 for the complete questions and the list of the possible answers.

The following two questions were finalized to know the students's perceptions about landslide and flood risk. With regard to the question “How could the communication between local authorities and citizens regarding geo-hydrological risk be improved?” (QC11 in Table A2), the most frequent answers were “public involvement through conferences and training initiatives” (181), “Through the web communication channels: Facebook, Twitter, etc.” (179) followed by “Through the dissemination of emergency plans” (103), “Through the activation of web communication forums” (83) and “Through information brochures to be sent to citizens” (32). Only 15 respondents chose “There is no need to improve it”.

The level of students's safety was explored through the following multiple-choice question “If you were involved in a geo-hydrological event who would you rely upon to decide what to do?” (QC12 in Table A2). The most frequent answers were “civil protection and fire fighters” (195), “police” (150) and “family and relatives” (121), followed by “local administrations” (72), “voluntaries” (51) and “friends, neighbours, colleagues” (37).

4.3. Common questions between Calabrian and Umbrian questionnaires

The three questions in common between the two surveys, finalized to test students' level of perception about geo-hydrological phenomena, are analyzed below.

In the first common question, interviewees were asked to indicate the factor(s) that they thought were crucial in the affecting landslide and flood risk. In the survey conducted in Umbria (QU16 in Table A1), the interviewees were specifically asked to choose from a list of nine possible factors, including bad luck; climate change; landscape characteristics; overbuilding; inappropriate land management; deforestation; modification of watercourses; public administrators' lack of interest; lack of mitigation structures. The “do not know” answer was also possible. For the analysis, the sum of “considerably” and “somewhat” answers was considered as a positive reply and the sum of “little” and “not” answers as a negative reply. Moreover, the percentage of positive replies for each factor was compared to all positive replies. Overall, the Umbrian youngsters considered the landscape characteristics (15%) as the main factor influencing landslide and food risk. CC obtained a percentage similar to inappropriate land management (12% and 13%, respectively). The choices with the lower percentages were overbuilding (8%) and bad luck (5%). In the Calabrian survey a multiple-choice question was proposed (QC8 in Table A2). The Calabrian youngsters considered the “inappropriate land management” (22%) and “climate change” (21%) the main causes for landslide and food risk, followed by “illegal building” (15%), “public administrators' lack of interest” (11%), “citizens' low interest” (11%) and “landscape characteristics” (10%). The answers “absence of protection works” and “abandonment of agriculture” were chosen by 5% and 2% of the respondents, respectively.

The second common question (QU17 in Table A1 and QC9 in Table A2) regarded the communication channels preferred by students to be informed on landslide and flood risks. In this case, the interviewees could provide multiple answers. In Umbria (Fig. 4A),

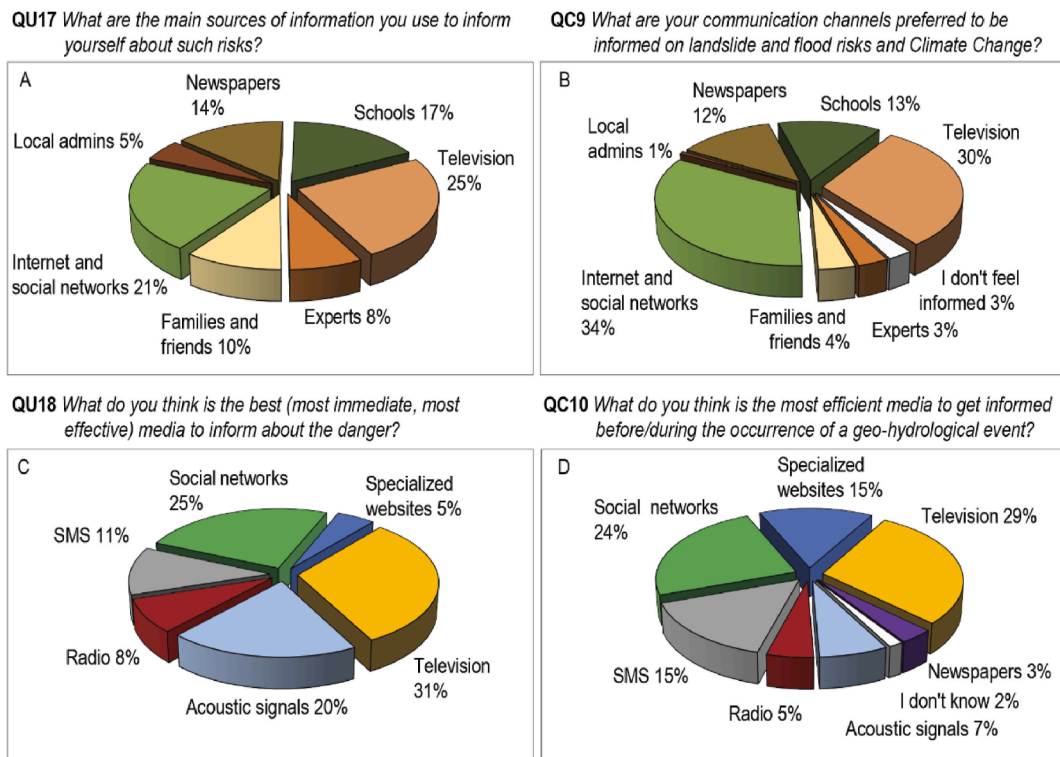


Fig. 4. Pie charts showing the answers to two common questions between Umbria (A, C) and Calabria (C, D) surveys. See Tables A1 and A2 for the complete questions and the list of the possible answers.

the sources most used by young people to gather information on such risks are television (25%) and internet/social networks (21%), followed by schools (17%) and newspapers/magazines (14%). Families and friends were selected only by 10% of the interviewed, while experts such as universities, research institutions, and civil protection totaled only 8% of the answers. Regional and municipality institutions were considered as good information source only by 5% of the respondents. In Calabria (Fig. 4B), the most frequent answers of the multiple-choice question regarding the communication channels preferred to be informed on landslide and flood risks and CC were “Internet/social network” (34%) and “TV” (30%) followed by “school” (13%) and “newspapers, books, magazines” (12%). The answers “friends and family”, “university and experts” and “I don't feel informed” were chosen by 4%, 3% and 3% of respondents, respectively. Only 1% chose “local administrations”.

The third common question concerned the source of communication/information that the students considered most effective to keep up to date before or during a geo-hydrological event (QU18 in Table A1 and QC10 in Table A2). In Umbria (Fig. 4C), the students selected television (31%) and social networks (25%) as the most efficient media, followed by acoustic signals as sirens (20%). Conversely, SMS (11%), radio (8%), and civil protection specialized websites (5%) obtained lower choices. In Calabria (Fig. 4D), the most frequent students' answers to the same question are “Television” (29%), “social networks” (24%), “SMS/WhatsApp” (15%) followed by “specialized websites (i.e. civil protection)” (15%). The answers “acoustic signals”, “radio” and “newspapers” were chosen by 7%, 5% and 3% of respondents, respectively. Only 2% answered “I don't know”.

5. Discussion

5.1. Umbrian survey

Analyzing the responses given in Umbria, it can be noted that the students interviewed felt more exposed to earthquakes rather than landslides and floods (QU1 and QU4 in Table A1). In fact, Umbria region has experienced severe earthquakes [69,70] and it is classified at high or very high seismic risk [71]. However, the high percentage resulted in QU1 is remarkable, since the survey was conducted before the 2016–2017 seismic sequence in Central Italy, including nine shakes of $M_w \geq 5.0$ that caused 299 fatalities [72,73]. The young interviewees' low perception of landslide and flood risk (Fig. 2A) confirms the findings of [37] who investigated the geo-hydrological and seismic risk awareness in 27 schools in Tuscany (Central Italy).

On the other hand, the high frequency and abundance of floods and landslides in the region [74–76] contrast with the low direct experience or indirect knowledge of such events (QU2). Despite this low experience/knowledge, the majority of them (59% of positive replies to QU3) considered landslides and floods to be a threat to their personal safety. This high value can be explained with the severe events that struck central and northern Italy in the period 2012–2014, with particular intensity and abundance during 2014, that caused a total of 75 fatalities, 2 missing people, 124 injuries, and more than 21,000 displaced people (<https://polaris.irpi.cnr.it/>

report/, last accessed 20 Nov. 2022). The media coverage of the events and the videos spread by social media contributed to increase the perception of the dangerousness of such phenomena. Such events probably impacted on young people's perception in Umbria.

Regarding the specific knowledge about the physical processes leading to landslide and flood initiation, the responses to QU7 and QU8 highlighted a deeper knowledge of the landslide causative processes rather than the flood ones. In fact, the intense and prolonged rainfall scored high percentage as landslide triggering factor, while, contrarily to what expected, a dike breach or a fluvial overflow were not selected as causative factors for floods. This could be interpreted as a sign that pluvial flooding was more perceived than fluvial flooding in the region, also due to several problems occurred to the drainage systems of the major urban areas.

Regarding the level of information about landslide and flood risks (QU9), the percentage of respondents that feel poorly or not at all informed is higher than in other surveys conducted in Italy (e.g. Ref. [32]; surveying both adult and young people).

To better investigate Umbrian youngsters' feelings on landslide and flood causative factors, and how these feelings are related to their personal behaviour and to other external factors, the responses to some of the above-listed questions were compared and analyzed.

Regarding QU16, 36 out of 58 respondents in Umbria (62%) "considerably" or "somewhat" agreed that CC can be a cause of landslides and floods in their territory. Among these, 81% (29 out of 36) and 89% (32 out of 36) use the internet and television to be informed on geo-hydrological risks (QU17), respectively, revealing the impact of these communication channels among youngsters and their interest in these topics. Moreover, 21 out of 36 answered "yes" to the question "Do you think that geo-hydrological events such as landslides and floods can be a real threat to your personal safety?" (QU3). Conversely, the majority of these respondents that revealed to be informed and aware of CC and geo-hydrological consequences, do not feel (answering "little" or "not exposed") to be threatened by landslides (29 out of 36) and floods (31 out of 36). From these replies, it could be inferred that a higher awareness on a global problem such as CC has a local implication in the perception of dangerous geo-hydrological phenomena.

To analyze in details some specific questions, the answers of QU2, QU7, QU8, QU13, QU14, and QU16 (Table A1) were compared pairwise, searching for some relations. In particular, the Yes/No dichotomous replies to the questions QU2 and QU13 were compared to the numerical-scale-based replies to the questions QU7, QU8 (from 1 to 5), and the qualitative answers to QU14 and QU16 converted into codes from 1 to 4, as described in Section 3.3. Finally, 0 and 1 values were assigned to the Yes and No responses of QU2 and QU13. Fig. 5 shows the average values of the numerical-scale-based answers to the questions QU7, QU8, QU14 and QU16 either QU2 and QU13 were answered "Yes" (red and dark green bars in Fig. 5) or "No" (pink and light green bars in Fig. 5), respectively.

First, the replies of the respondents that have had direct experience of landslides or floods (Yes answers to QU2 in Table A1; red bars in Fig. 5) were quantitatively compared to other answers. In particular, the respondents with direct experience revealed to have a

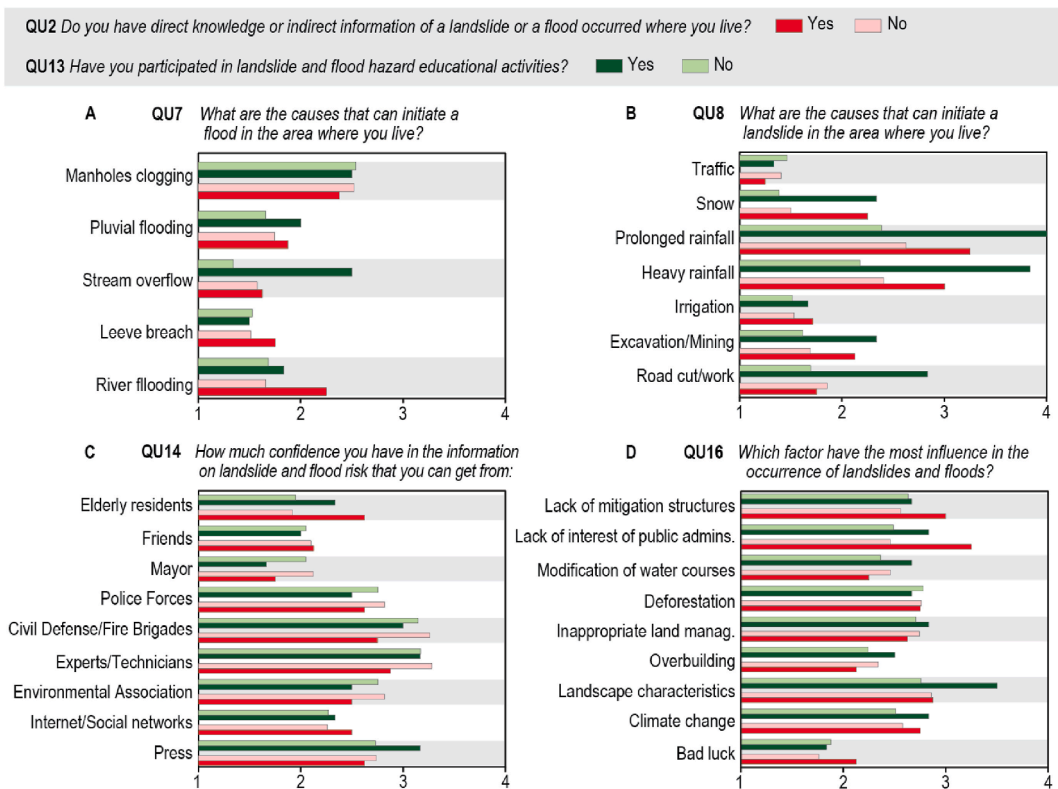


Fig. 5. Average values of the numerical-scale-based answers to the questions QU7, QU8, QU14 and QU16 either QU2 and QU13 were answered "Yes" (red and dark green bars) or "No" (pink and light green bars). Refer to Table A1 for the complete questions and possible options. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

good knowledge of the triggering factors of such phenomena. Indeed, the replies to QU7 and QU8 indicating the correct triggering factors obtained an average difference of the replies converted in values according to the Likert scale [67] ranging from 0.5 to 0.8. For example, as it is shown in Fig. 5B, the options “heavy rainfall” and “prolonged rainfall” to QU8 scored the highest average values (3.0 and 3.3, respectively) in the case the interviewee replied “Yes” to QU2. Moreover, they considered the public administrators' lack of interest and the lack of mitigation structures as relevant factors contributing to the occurrence of landslides and floods (QU16 in Table A1). In particular, in case of respondents who directly experienced landslides and floods, the public administrators' lack of interest obtained an average value of 3.3 and the lack of mitigation measures obtained 3.0, while, in case of no experience, the average values were 2.5 and 2.6, respectively (Fig. 5D). Remarkably, the respondents with direct experience of landslides or floods manifested a lower confidence in the information that they can get from experts, technicians, scientists and civil defense (QU14 in Table A1), passing from an average value of 2.8–3.3, in case of yes or no answers to QU2, respectively (Fig. 5C). These findings confirm how young people's perception and knowledge of a hazard are highly related to their direct experience, in line with the topic literature ([25,32] and references therein). In fact, the latter contributes more than the indirect knowledge or study to awareness increase, as also observed by Ref. [77]. In this respect, a practical educational activity, as a civil protection exercise, can enhance citizens' awareness, preparedness and disaster response [78,79].

In this regard, the replies of the respondents that have participated in educational activities on landslide/flood hazard (Yes answers to QU13 in Table A1; dark green bars in Fig. 5) were analyzed. It can be observed that participation in such activities helps increasing the knowledge level of the landslide and flood triggering factors. This aspect is much more evident in the case of landslides (Fig. 5B), for which the average values of the option “heavy” and “prolonged” rainfall to QU8 pass from 2.2 to 2.4, respectively (in case of no educational activities) to 3.8 and 4.0 (in case of having participated in them). In addition, the student that joined educational activities thought that the landscape characteristics influence the occurrence of landslides and floods (QU16 in Table A1), passing from an average score of 2.8–3.5 (see light and dark green bars in Fig. 5D). Similar outcomes were reported in a research article conducted within the European research project LIFE PRIMES [80]. The results obtained show that involving citizens in flood risk reduction activities (i.e., civic adaptation plans, workshops, alert simulations, theatrical plays) can significantly improve the effectiveness of communication, increase the knowledge of flood phenomena, and strengthen the citizens' sense of responsibility towards flood risk reduction.

Remarkably, either they had a direct experience of an event (Yes answers to QU2 in Table A1) or they attended a specific educational activity on landslide and flood hazard (Yes answer to QU13 in Table A1), they revealed a very low confidence in the mayor's information on such phenomenon (average value of 1.7 in the answers of QU14 in Table A1; Fig. 5). This result deserves attention because, according to the Italian laws, the mayor has the main civil protection powers at the municipality scale and each municipality must have a civil protection emergency plan [81]. This result was observed also in Tuscany by Ref. [32].

5.2. Calabrian survey

The analysis of the results of the Calabrian survey indicates that the majority of the young people interviewed are aware of the CC issue, and most of them expressed concerns about the oncoming impacts related to CC. This result is in line with the recent literature (e.g. Ref. [82]), and in particular with a recent survey carried by Ref. [30] according to which the worry about the current climate crisis is weaker in older generations.

Compared to results of [12], who investigated the perception of CC among two municipalities located in southern Italy, this study highlighted that students are apparently more concerned than adults about the impacts of CC on nature and the environment (QC1, QC4, QC5 in Table A2). This result is likely to be related to the numerous events/initiatives on the topic of CC and environment impacts that, in recent years, have increased public awareness and in particular young people's. Furthermore, the international movement “Fridays for Future” and the first “Youth4Climate Manifesto” sent to governments and political decision-makers worldwide on the occasion of COP26 in Glasgow [83] highlighted the level of awareness of the new generations on issues related to CC.

To better investigate the feelings and trustworthiness of the Calabrian youngsters on the actions taken by governments to mitigate CC, the responses to QC4 and QC7 were compared pairwise to look for possible relations (Fig. 6). Although about half of the young people think that policy measures to face the CC phenomenon are insufficient, a sizable portion is confident that these actions are being implemented. It is also noteworthy that almost all of the young people who think that national governments and international institutions are not doing enough to tackle CC (negative replies to QC4) feel more frustrated, because not enough is being done about CC, and are also afraid of its possible effects (QC7). At the same time, however, it emerges that an equally large portion of young people do not respond to the question regarding the government actions to mitigate CC (“I don't know” replies to QC4). So, on the one hand the results highlight that Calabrian young people have more confidence than adults in politics [12], on the other hand it is worrying that about a quarter of the young people interviewed do not respond to a topic that should closely involve them.

In line with the current literature, also in this study the respondents considered melting glaciers as the first phenomenon linked to CC (QC2), followed by rising temperatures. The fact that young people have indicated the “geographical distant phenomenon” of the melting glaciers as a primary CC sign is probably due to photos and videos streamed by the media. Being CC a phenomenon not easily identifiable from personal experience, most that is known about this phenomenon comes from media communication. In particular, the social media use the images of melting of glaciers and disintegrating ice shelves to represent CC and to make the phenomenon more tangible to lay public [84–86]. Furthermore, the influence of the social media is even more relevant for young people as they consider the search engines on the internet and the news websites the best way to get information [87].

Results also show that most students perceive the human activities as an important cause of CC, and that lifestyle also affects it (QC3). At the same time, a large proportion of students believe that CC is related to the natural evolution of the planet. This finding indicates that these students don't recognize that human activities have begun to influence the climate, and consequently they will

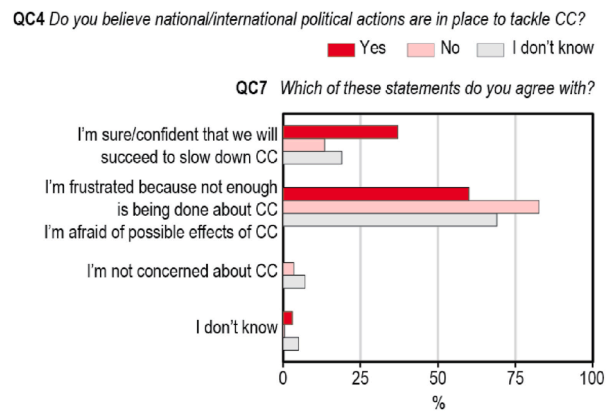


Fig. 6. Comparison among the answers to the questions QC4 (colors) and QC7 (bar size). Refer to Table A1 for the complete questions and possible options. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

not feel involved and will not take any action to reduce the effects of CC. Moreover, because the survey of [12] showed that the same statement “climate change is linked to the natural evolution of the planet” is negatively correlated to respondents with higher education (tertiary level), the results of the present work point out the need for better teaching/learning the processes of CC in the Italian high schools.

Almost all students interviewed agree on the need for strengthening communication on geo-hydrological risk between citizens and authorities. This should be implemented through training initiatives and through web communication channels (e.g., social media) involving citizens (QC11). The importance of digital devices in communication about disasters also resulted from a participatory research with more than 550 European children and young people [65]. A communication gap has also been expressed by adults [24,25]. For example, according to [25], the majority of the adults surveyed did not believe that civil protection organizations and/or authorities had adequately informed them about local natural hazards and effective evacuation methods.

The case study highlights the need for improving risk communication between authorities and citizens. In particular, local authorities and experts have to create the conditions for disseminating risk knowledge and increasing the level of safety of an area by a bottom-up approach with participated actions [25,88]. However, communicating about environmental hazards requires not just alerting the citizens but also assessing their comprehension of the messages [89,90]. Anyone who communicates must actually be “conscious” of the community's needs, requirements, level of comprehension, and preferred communication channels. This is even more important for young people. [65] underline the ability, desire and right of young people to participate actively in disaster risk management, demonstrating how practitioners can benefit by involving them.

The results obtained in the Calabrian survey show that the respondents, in case of geo-hydrological events, are more confident in the actions of civil protection, fire fighters and police (QC12). Most likely young people are informed and recognize the important role of the civil protection system in emergency management. This result is in line with the findings obtained from other studies in Italy, which highlight the significant role that civil protection must also play in promoting the exchange of information and knowledge between science, policy and citizens [32,91].

The student's low trust in municipal/local administrations depends on the widespread low interest that local administrators show towards the problems of the territory. Similar results were obtained by various authors through surveys involving adults (e.g., Refs. [20,32,92]).

5.3. Common questions about students' geo-hydrological risk perception of

The students interviewed consider territory management and CC as the main causes of geo-hydrological phenomena in both investigated regions (QU16 and QC8). This result on the one hand confirms the youngsters' ability to recognize the relation between CC and the frequency and intensity of landslides and floods; on the other hand it highlights the negative opinion that students have on the policies regarding geo-hydrological risk. This feeling seems to be common in the Italian public opinion tested in different age categories [16,32]. As for illegal constructions, the results of the survey in Calabria confirmed a peculiar “perception of people living in southern Italy”; in fact, “abusive” (i.e. illegal) constructions are considered relevant factors for landslides and floods in that territory [16,20]. More in detail, the factors of “illegal constructions” and “territory management” have been mostly perceived by students living in Rossano municipality. Probably, these feelings are related to the notable damage induced by an intense and localized rainfall event that struck the area on August 12, 2015 [93]. During this event, heavy rain (408 mm in 19 h, with a peak value of 160 mm in 4 h; <https://polaris.irpi.cnr.it/event/alluvione-rossano-e-corigliano-calabro-cs>, last accessed 15 Nov. 2022) caused flooding along the water network, and soil erosion as well as shallow landslides. The damage caused by the heavy rainfall event was related to both its severity and the intense urbanization/anthropization, often unguided, which affected much of this coastal area after the 1970s, together with the absent maintenance work of hydrographic network [94].

Both Calabrian and Umbrian surveys have revealed that the internet, social media and television represent the primary information sources on geo-hydrological risk and CC for the young people interviewed (QU17 and QC9), as found in other Italian surveys [32]. In particular, in Calabria, the internet and social networks scored the highest percentage; this preference order is reversed to

what obtained by Ref. [12] for adults in the same region. It is worth highlighting that higher reliance on social networks in Calabria compared to Umbria can be due to the fact that the interviews in Calabria were done five years later. This result confirms that young people prefers social media as means of communication/information sources compared to traditional media, in agreement with the rising importance that social media have recently acquired worldwide. Remarkably, many organizations use these forms of electronic communication to spread information during the different emergency phases (before, during or after the event; [95]). On the other hand, the low values recorded for school, experts, universities, and regional/municipality administrations underline a communication breakdown between these institutions and young people.

In both surveys, television is chosen by young people as the best source of communication to be informed before or during the occurrence of a geo-hydrological event, followed by social networks (QU18 and QC10). This choice highlights that young people identify television as the most powerful means of communication, capable of offering important messages and food for thought [87]. Moreover, information gathered from television can be somehow considered a shared experience among youngsters and parents/relatives, leading to an awareness increase.

6. Conclusion

To address the complex issues related to CC and its impacts, mitigation and adaptation measures are being adopted worldwide. For an effective implementation of adaptation and mitigation actions, it is a priority to pursue a set of goals that will help to have an overall more prepared society in which such actions can be developed [1]. Within this framework, education, training, communication and knowledge dissemination, together with active public participation in implementing specific mitigation and adaptation measures, ensure the successful adoption of such measures. In particular, analysing the awareness, the degree of knowledge and the preparedness of young people toward these issues becomes increasingly important.

This study focused on young people's awareness, perception and preparation on CC and landslide/flood risk by analysing a sample consisting of Italian high school students, aged 13 to 20, in central (Umbria region) and southern (Calabria region) Italy.

The results of the surveys reveal that the students surveyed are aware of the CC issue and are more concerned than adults about the impacts of CC on nature and the environment. They generally believe that human actions and lifestyle affect CC. At the same time, however, the frustration and anxiety expressed by the young people interviewed, associated with their awareness of CC, would require a greater consideration by the societal actors aiming to pay attention to negative emotions associated with CC [96,97].

The obtained results confirm the close link between young people and the mass media (particularity social media) in terms of perception, knowledge and information about CC and related effects. Mass media, along with family, friends, and cultural background, play an important role in influencing young people's behaviours and attitudes. In addition, an effective communication by media can stimulate young people to become even more interested in social, environmental and political issues and, at the same time, involve those who show weak, scarce or no interest about these problems. Moreover, the need expressed by the surveyed young Italians to improve risk communication between authorities and citizens – and their low level of trust in local administrations – indicates that local/national governments need to properly communicate and educate young people making them informed, active citizens.

As underlined by [44], also in this research it was found that young interviewed who have participated in a specific educational activity on landslide and flood hazard had a good understanding of landslide and flood triggering factors. Education has a primary role in communicating CC and its impacts, as well as in increasing environmental awareness among youth [37,55,56]. However, despite the unanimous recognition of the important role of risk education programs in increasing awareness and coping with risks in young and adolescents, most of schools' curricula do not provide in-depth formal education on natural hazards and CC. According to a recent UNESCO assessment, CC was not addressed in 47% of the national curriculum frameworks of 100 countries [98]. In Italy, environmental topics (including CC) have been introduced within the Civic Education discipline in the curriculum of primary, secondary, and adult education only from 2020. Progress has been made in climate education in schools and formal education, but further efforts are needed. In addition, great importance must also be assigned to CC and natural hazards' preparation, awareness and perception of the school staff [37,98].

Finally, considering the current climate projections, the involvement of young people in practical training such as civil protection exercises will be more and more important to improve their prevention, preparedness and disaster response.

Although the student samples are not representative of the population at large, the above results are useful to discuss the perception, knowledge, and communication of geo-hydrological risk and CC within the Italian young people. Understanding how young people perceive geo-hydrological risks and CC is relevant for an effective dissemination of information; the final goal consists in increasing trust in authorities and improving the ability to react to highly impactful events, and thus increasing people's resilience. Knowing the needs of citizens, and in particular of young people, is the first and necessary step toward greater sharing of intervention policies that will be needed to strengthen resilience and adaptation to CC. From this point of view, the theme approached in this research is in line with what is being done at the national level in Italy on the issue of CC adaptation.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijdr.2023.103663>.

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